INDOOR AIR QUALITY ASSESSMENT

South Middle School
232 Peach Street
Braintree, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
July, 2002

Background/Introduction

At the request of Peter Kress, Business Manager for Braintree Public Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA), provided assistance and consultation regarding indoor air quality concerns at South Middle School in Braintree, Massachusetts. On April 11, 2002, Cory Holmes, Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, and Suzan Donahue, Research Assistant, conducted an indoor air quality assessment of the building.

The school is a two-story brick building constructed in 1956, which houses grades 6-8. Two modular classrooms were added in 2001. The school is built in three levels up the side of a small hill. The second floor is made up of general classrooms. The first floor consists of general classrooms, media center, nurse's office, cafeteria, kitchen, teachers' dining room, auditorium, gymnasium and office space. Locker rooms, art rooms, a wood shop and the boiler room are located at the ground floor level. Windows are original single-paned sash windows, which are openable throughout the school.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

This school has a student population of 554 and a staff of approximately 60. Tests were taken during normal operations at the school and results appear in Tables 1-8.

Discussion

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in twenty-one out of fifty-five areas surveyed, indicating a ventilation problem in some areas of the school. Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns were seen in a number of classrooms (see Picture 1). The univent in the media center contained accumulated dirt/debris. This univent should be cleaned before operating to prevent aerosolization of this material. In order for univents to provide fresh air as designed, intakes must remain free of obstructions and allowed to operate while rooms are occupied.

Supply ventilation in the cafeteria was designed to be provided by three univents along the exterior wall (see Figure 2). Two classrooms were constructed within the cafeteria, which enclosed two of the three univents. The cafeteria ventilation was reduced by two-thirds of its design capacity with this alteration (see Figure 3). In addition, the one remaining univent was not functioning at the time of the assessment. School officials reported that a replacement motor was on order for this unit. Further reducing cafeteria air circulation is the location of the exhaust vent in relation to the univent (see Picture 2). As air is introduced by the univent it tends to be directed out of the cafeteria via the exhaust vent (called short-circuiting). This configuration would limit

the distribution of air to the occupied areas of the cafeteria where occupants sit (see Figure 3).

The modular classrooms have a ventilation system that is separate from the rest of the school. Fresh air in modular classrooms is provided by rooftop air handling units (AHUs). These AHUs should both draw fresh air into the intake hood and exhaust stale air from the return vent. The AHUs distribute fresh air into ductwork connected to ceiling-mounted air diffusers. A thermostat controls each AHU. Modular classrooms are designed to be energy efficient. Therefore little outside air penetration occurs, except when windows are open. The thermostat controlling the modular classroom AHU has three settings: on, off and automatic. The automatic setting on the thermostat activates the AHU system at a preset temperature. Once a preset temperature is reached in the area of the thermostat, the HVAC system is deactivated. The thermostat was set on the "automatic" setting in modular room 99, which had turned off the modular classroom's ventilation system. Since the modular classroom is tightly constructed, air penetration through doors and windows is minimal. Once switched from the automatic setting to the on setting, carbon dioxide levels dropped as fresh air circulated through the room. The thermostat in modular room 98 was set to the fan "on" position and ventilation was operating.

Exhaust ventilation in general classrooms with univents is provided by a mechanical system. The exhaust system in each classroom consists of ducted, grated wall vents. Exhaust ventilation operates continuously. Exhaust vents were blocked by various items in many areas (see Picture 3). In order for exhaust ventilation to function as designed, vents must remain free of obstructions.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact

that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix 1 of this assessment.

Temperature readings were within a range of 67° F to 73° F, which were below BEHA comfort guidelines in some areas. The BEHA recommends that indoor air temperatures be maintained in a range between 70 ° F to 78 ° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control complaints in a number of areas were expressed to BEHA staff. Drafts were felt around window frames in many areas throughout the school where window caulking is missing, crumbling and damaged. In some areas occupants have inserted towels or fiberboard insulation around window frames to reduce drafts (see Pictures 4 & 5). It is difficult to control temperature and maintain comfort without operating the HVAC equipment as designed (i.e., univents deactivated/exhaust vents obstructed).

The relative humidity in the building was below the BEHA recommended comfort range in all areas surveyed. Relative humidity measurements ranged from 27 to 35 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and

irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of classrooms have water-damaged ceiling tiles which can indicate leaks from either the roof or plumbing system. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

Caulking around windows (interior and exterior) was crumbling/damaged throughout the building indicating that the water seal is no longer intact (see Pictures 6 & 7). Several areas had broken windows or windows replaced with plywood (see Picture 8). Water penetration through damaged window frames can lead to mold growth under certain conditions. In addition, towels used to soak up water around windows (see Picture 4) and other porous materials can serve as mold growth mediums. Replacement of caulking and repairs of window leaks are necessary to prevent water penetration.

Several classrooms contained a number of plants. Plant soil and drip pans can serve as sources of mold growth. One classroom contained a plant in standing water (see Picture 9), which can become stagnant giving off unpleasant odors. Plants should also be located away from univents to prevent aerosolization of dirt, pollen or mold.

The exterior walls had spaces/cracks in brickwork. In many areas mortar around exterior brickwork appears to be crumbling or missing (see Pictures 10 & 11). These conditions are breaches of the building envelope and provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building

materials and the potential for microbial growth. In addition large spaces may provide a means of egress for pests/rodents into the building. Signs of efflorescence were noted on walls and around windows. This is caused by water penetration through brick, dissolving minerals within the brick as it flows through. The water evaporates leaving a dry white residue known as efflorescence.

Both of the modular classrooms were examined. Guidance concerning preventing mold growth in modular classrooms was released in March 2002 by the Modular Building Institute (Stewart, B., 2002). According to this guidance, the following improvements can be made to avoid microbial growth within these structures:

1. Use of sloped roof with properly installed gutter and downspout system to drain rainwater.
2. Siting the structure on a well-drained surface.
3. Surface run-off should be directed away from the structure.
4. The crawlspace under the structure should be well ventilated.
5. Check all caulking and/or flashing around windows and service posts, especially after moving a structure.
6. Maintain ventilation according to American Society for Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) (Stewart, B., 2002).

Using these guidelines as evaluation points, the following is an analysis of the modular units:

The exterior walls of the modular units appeared to be intact. Drainage appears to be adequate. A gutter/downspout system exists for the units, preventing water on the roof

from wetting the exterior wall of the modular. There are minimal means for ventilating the crawlspace under this structure.

Other Concerns

Several other conditions were noted during the assessment, which can adversely affect indoor air quality. Open cans of acrylic paint were found in the wood shop (see Picture 12). This material contains volatile organic compounds (VOCs) that can be irritating to the eyes, nose and throat. In addition, the warning label claimed it is a highly flammable material. This material should be properly sealed and stored in a flammables storage cabinet that meets the specifications of the NFPA (NFPA, 1996).

BEHA staff received complaints concerning vehicle exhaust odors in the office areas. Idling buses in the driveway in front of the school can result in vehicle exhaust entrainment by the mechanical ventilation system and open windows under certain weather conditions; which may, in turn, provide opportunities for exposure to combustion products such as carbon monoxide. At the time of the assessment no vehicle exhaust odors or measurable levels of carbon monoxide were detected within the school. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL. 1986).

The main office and teachers' lounges have photocopiers. A laminating machine was also in the teachers' conference room. Laminating machines and photocopiers can give off irritating odors. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt

Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

Accumulated chalk dust and pencil shavings were noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

The building showed signs of insect infestation. Insect bodies were noted on windowsills in classrooms (see Picture 13). A wasp's nest was noted on the exterior of the building (see Picture 14). Insect parts can become dried out and aerosolized and may serve as a source of allergenic material for sensitive individuals. A combination of cleaning, sealing window systems and increasing ventilation and filtration should serve to reduce insect associated allergens once the infestation is eliminated.

Pesticide applicators should be in full compliance with the federal and state rules and regulations that govern pesticide use including posting and notification requirements (333 CMR 13.10). Under no circumstances should pesticide material(s) be applied by untrained personnel. Product(s) should not be applied prior to or during business hours. If application must be done during the school week, material should be applied shortly after the day ends, in order to give the applied areas ample time to dry. Under current Massachusetts law that went into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). A copy of the IPM guide is attached as Appendix II.

Classroom 201 contained two air fresheners placed over the univent. Air fresheners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. These items should not be located near the air stream of the univent where they can be distributed throughout the classroom. In addition, air fresheners do not remove materials causing odors, but rather mask odors which may be present in the area.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored in classrooms provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean around these areas. Dust can be irritating to the eyes, nose and respiratory tract. These items should be relocated and/or cleaned periodically to avoid excessive dust build up.

A number of exhaust and return vents in classrooms, restrooms and portable air conditioner filters were noted with accumulated dust (see Pictures 15 & 16). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

Conclusions/Recommendations

The combination of the building configuration, maintenance, work hygiene practices and the condition (age) of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be

remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns. The Braintree School Department has included a number of these projects on a Capital Planning Request list (see Appendix 3).

In view of the findings at the time of the visits, the following **short-term** recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Continue with plans to repair cafeteria univent. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate fresh air supply univents while classrooms are occupied. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Set the thermostats for modular classrooms to the fan "on" position to operate the ventilation system constantly during the school day.
4. Inspect exhaust motors and belts for proper function, repair and replace as necessary.
5. Remove all blockages from univents and exhaust vents.

6. Once both the fresh air supply and exhaust ventilation are functioning, the ventilation system should be balanced by an HVAC engineering firm. Have system balanced every five years to ensure proper function (SMACNA, 1994).
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Replace any remaining water-stained ceiling tiles and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Ensure all plants are equipped with drip pans. Avoid over watering, examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Consider reducing the number of plants.
10. Replace missing/dislodged ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms.
11. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
12. It is highly recommended that the principles of integrated pest management (IPM) be used to rid this building of pest. A copy of the IPM recommendations are included with this report as Appendix II (MDFA, 1996).

13. Remove cans of acrylic paint from the woodshop and dispose of in a manner consistent with state hazardous waste disposal law. Consider discontinuing usage of this material in a classroom environment.

14. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust. Empty pencil sharpeners regularly, keep immediate area clean of pencil shavings and associated debris.

15. Refrain from using strong scented materials (e.g., air fresheners) in classrooms.

The following **long-term measures** should be considered:

1. Based on the age, physical deterioration and availability of parts for ventilation components, the BEHA strongly recommends that an HVAC engineering firm fully evaluate the ventilation systems.

2. Work with HVAC engineer to provide adequate ventilation to the cafeteria and added classrooms.

3. Thermostat settings throughout the school should be evaluated. Repair/replace thermostats as necessary. Thermostats should be set at temperatures to maintain comfort for building occupants.

4. Consider having windows replaced or proper flashing installed to prevent further water intrusion. Repair water damaged windowsills, walls and other building materials. Examine these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

5. Consider having exterior brick repointed. Consult a building engineer for best method to repair damaged exterior brick, which may include waterproofing to

prevent further water intrusion. Repair/replace water-damaged building materials. Examine surrounding non-porous areas for mold growth and disinfect with an appropriate antimicrobial if necessary.

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Figure 3 **Current Cafeteria Configuration of Mechanical Ventilation and Airflow**

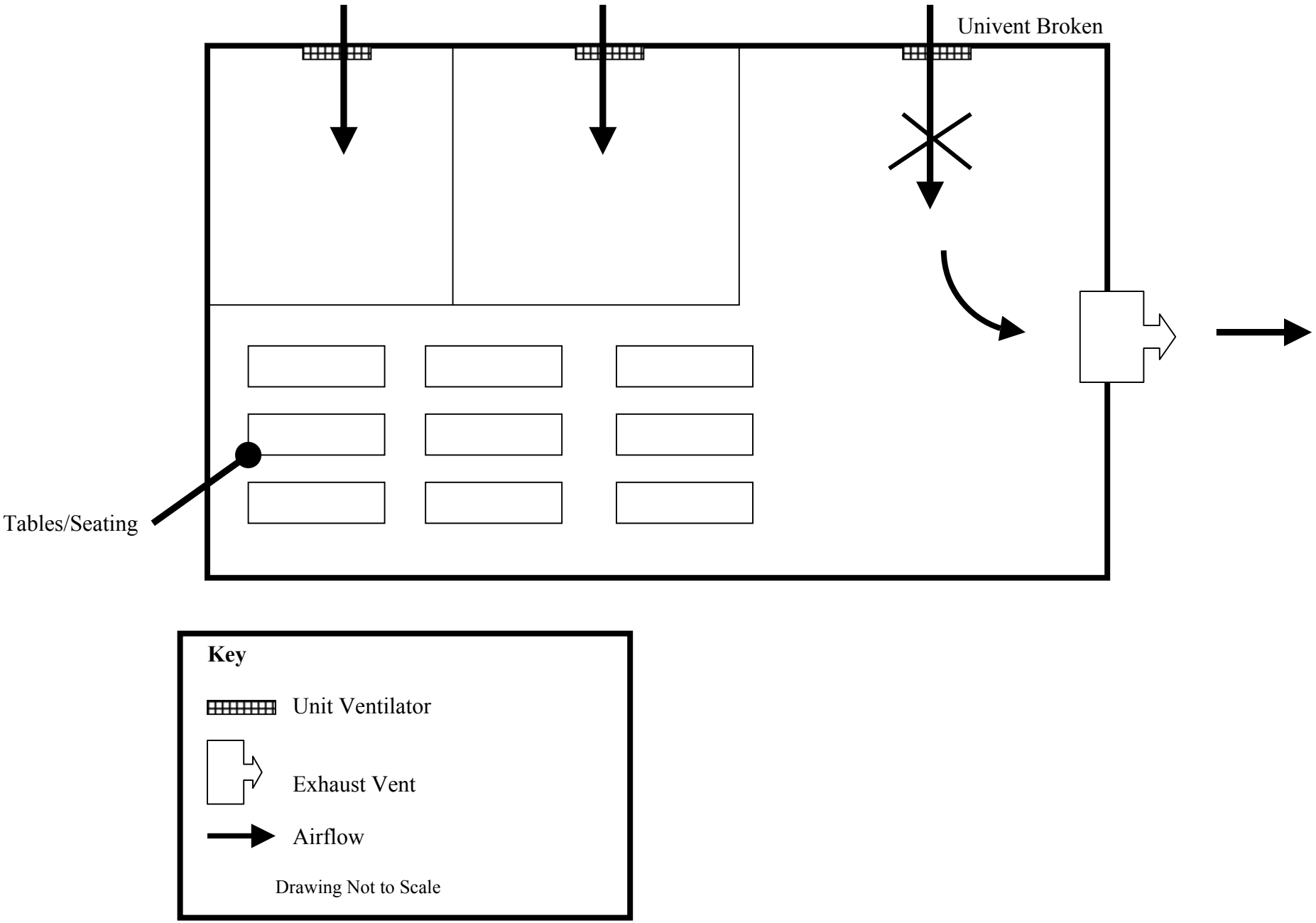
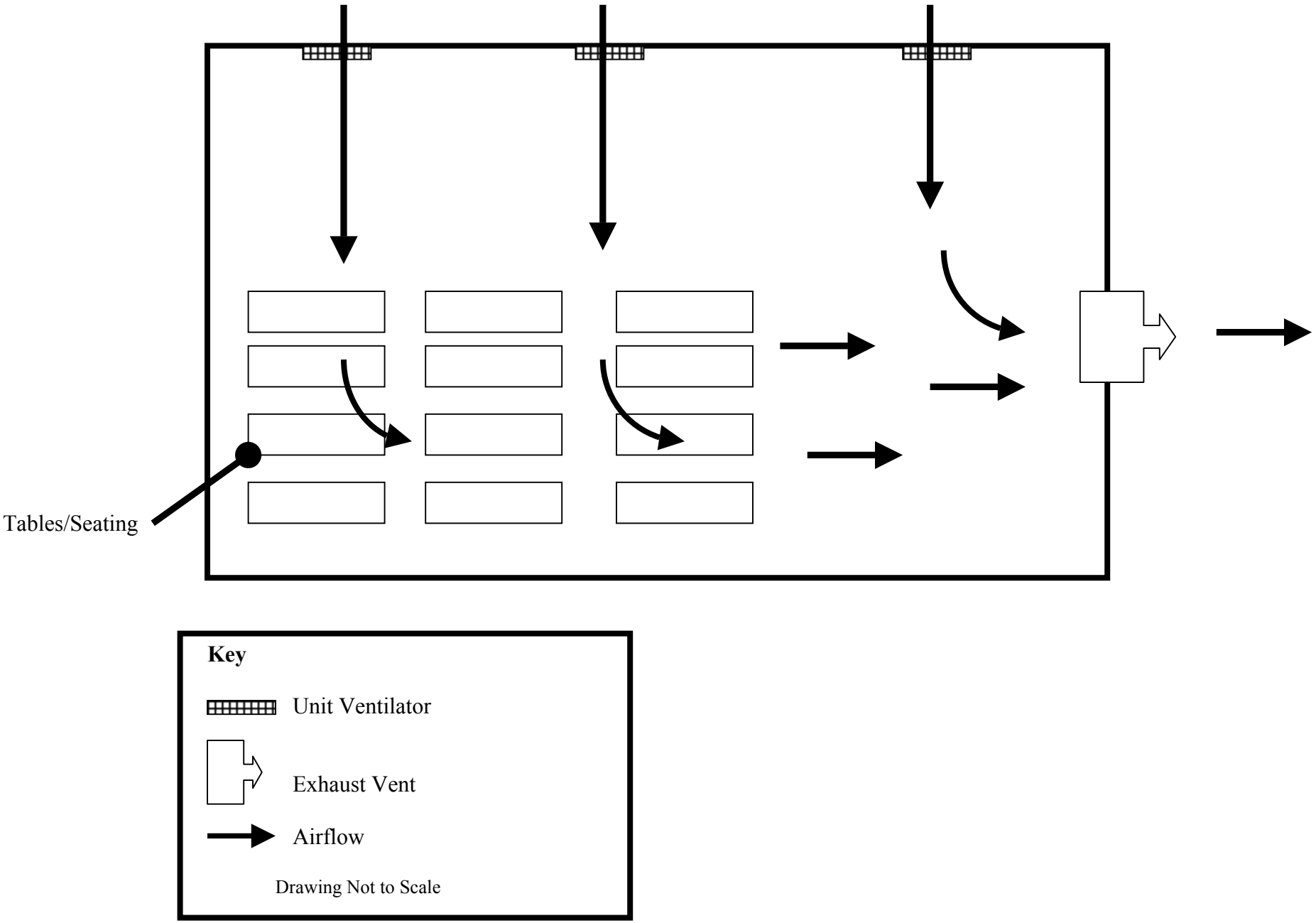


Figure 2 **Original Cafeteria Configuration of Mechanical Ventilation and Airflow**



Picture 1

Items in Classroom Obstructing Univent Airflow

Picture 2

added classrooms cafeteria univent (one of three original units) cafeteria exhaust vent

Longview of Current Cafeteria Configuration

Picture 3

Classroom Exhaust Vent Obstructed by Water Bottles/Crates

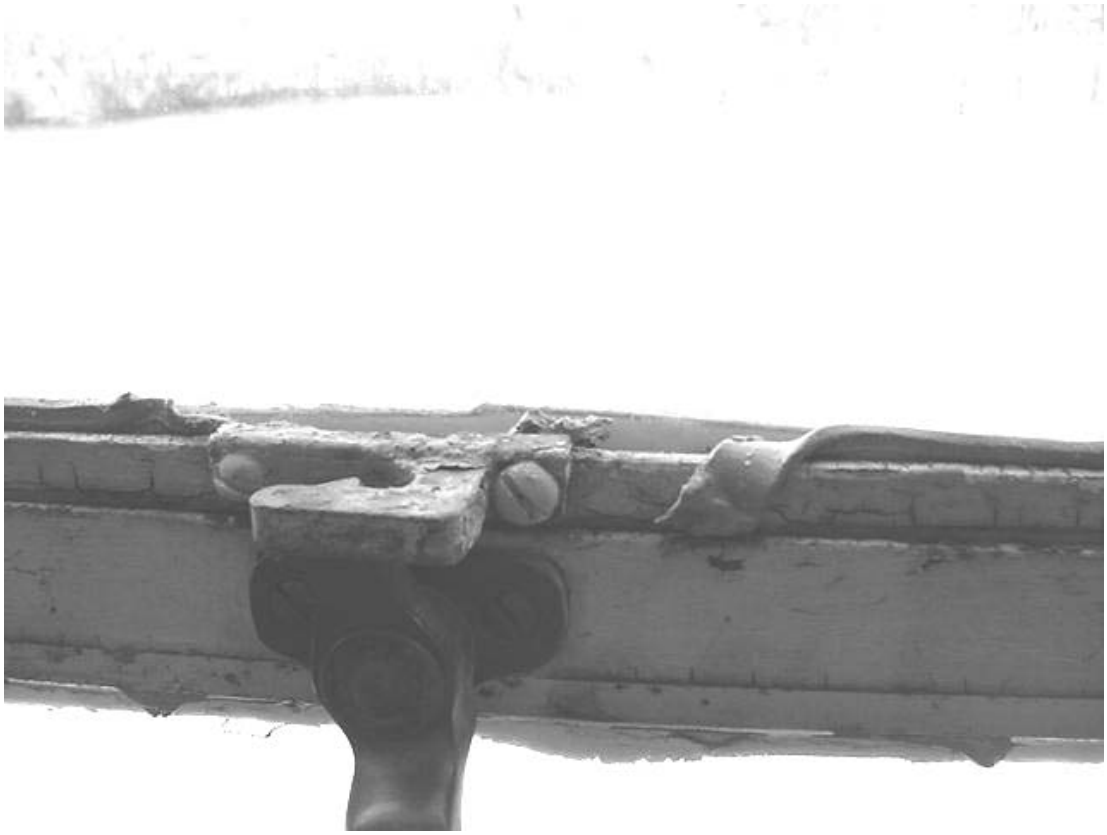
Picture 4

Towel Stuffed between Window Frame in Classroom

Picture 5

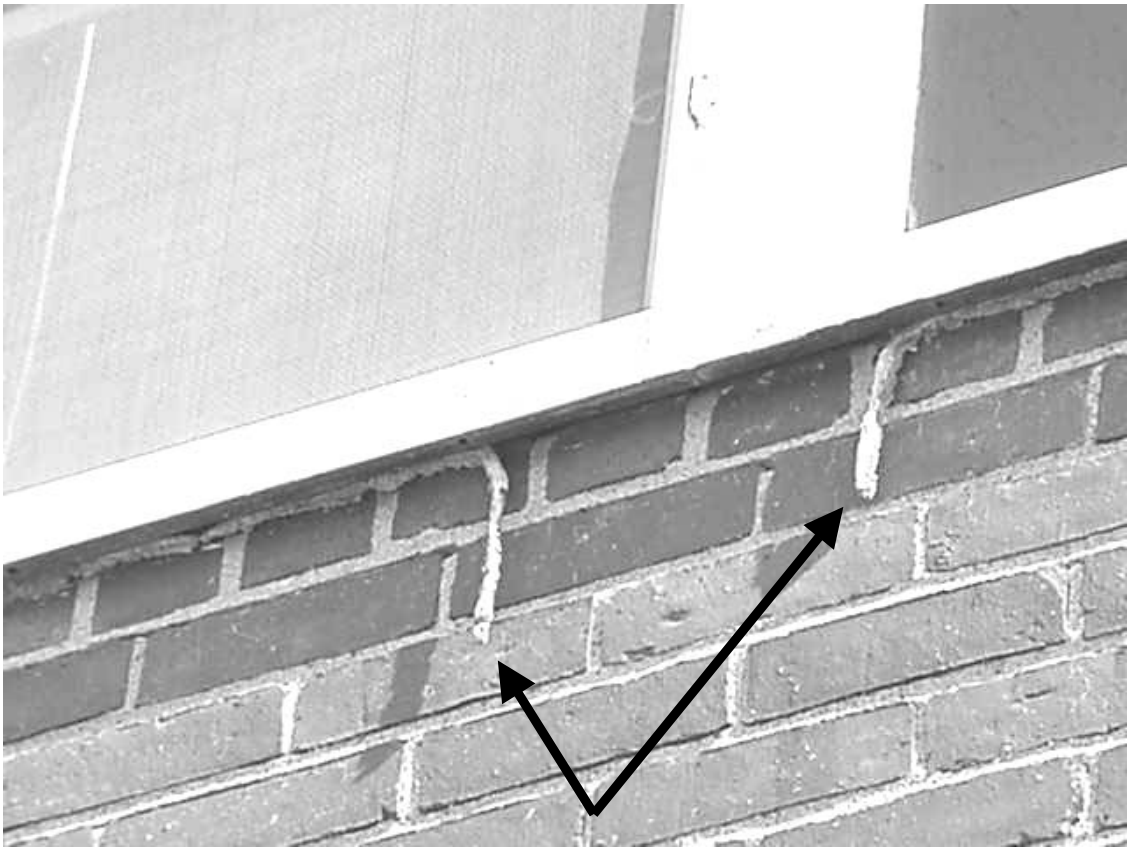
Fiberboard Stuffed between Window Frame in Classroom

Picture 6



Missing/Damaged Window Caulking in Classroom

Picture 7



Failing Caulking around Exterior Window Frames

Picture 8

Broken Window Replaced with Plywood

Picture 9

Plant in Standing Water

Picture 10

Crack/Fissure in Exterior Brickwork

Picture 11

Missing/Damaged Mortar around Window Frame

Picture 12

Open Can of Acrylic Paint in Woodshop

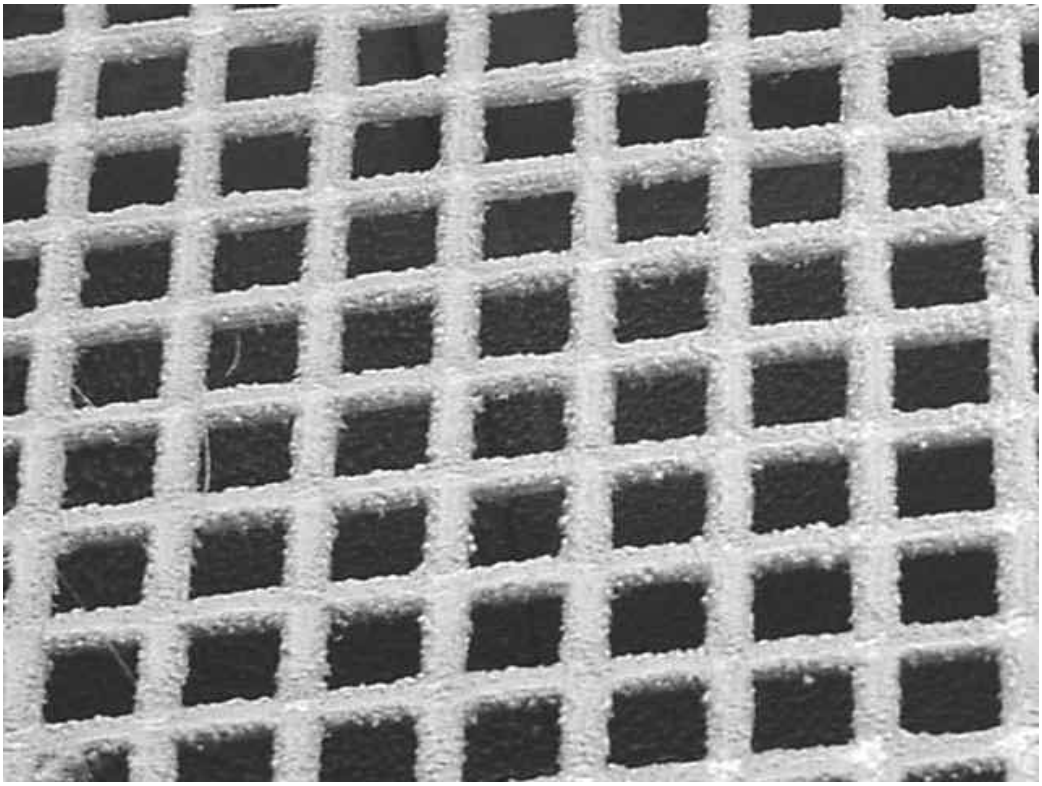
Picture 13

Insect Bodies on Windowsill in Classroom

Picture 14

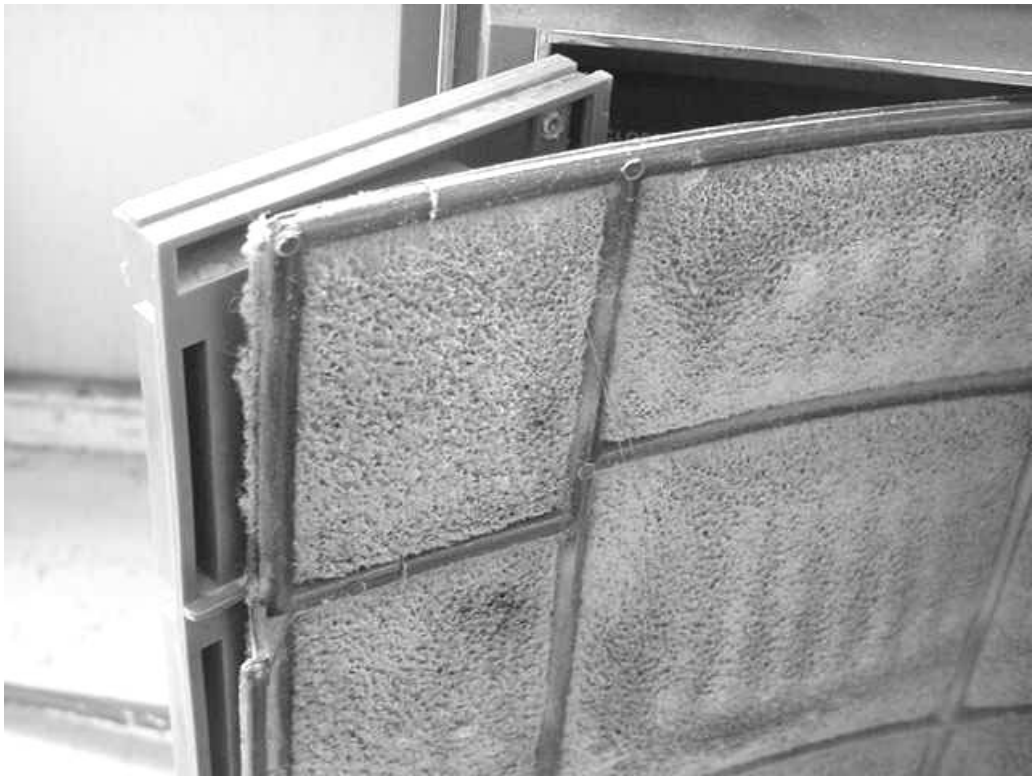
Wasps/Hornets Nest Exterior near Window Frame

Picture 15



Accumulated Dust on Exhaust Vent Grill

Picture 16



Accumulated Dust on Air Conditioner Filter

TABLE 1

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	382	55	34					Weather conditions: cool/sunny, clear skies, wind-NE 5-10 mph
Perimeter Notes								Missing/damaged-mortar/brick, failing caulking, wasps nests-near ball field, shrubbery against building
Room 201	862	70	33	22	Yes	Yes	Yes	Door open, accumulated items, 2 air fresheners over univent, exhaust vent partially blocked by crates and open door, cleaning product, humidifier, 2 plants
Room 202	1370	69	34	22	Yes	Yes	Yes	
Room 204	1091	69	34	22	Yes	Yes	Yes	Door open
Room 203	939	70	33	25	Yes	Yes	Yes	10+ plants, window planter, hole in CT, exhaust vent partially blocked
Room 201	1530	70	35	0	Yes	Yes	Yes	~20 occupants gone 1 min., door open
Room 205	720	67	30	0	Yes	Yes	Yes	15-20 occupants gone <5 mins., door open, aquarium

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
208	1305	68	34	0	Yes	Yes	Yes	15-20 occupants gone <10 mins., door open, hole in wall-cavity around thermostat
Room 209	918	71	33	29	Yes	Yes	Yes	Gerbil, door open, chalk dust/dry erase board particulate, missing window-sealed with plywood, plants/1 plant in standing water
Room 211 (Computer Room)	623	69	30	21	Yes	Yes	Yes	Window-mounted air conditioner-fan function, 20+ computers, no draw from exhaust, check pull chain/flue
Room 212		70	29	9	Yes	Yes	Yes	Dust accumulation on exhaust vent, exhaust vent behind bookcase, water damaged CT, 2 dislodged CT,
Hallway								Water-damaged CTs
Room 213	842	70	33	17	Yes	Yes	Yes	Window-mounted air conditioner-filter dirty, 20+ computers, heat complaints, door open
Room 214	560	71	29	12	Yes	Yes	Yes	Water-damaged CT-corner-painted, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 207	566	67	27	21	Yes	Yes	Yes	Door open
Stage/Auditorium	672	70	33	19	Yes	Yes	Yes	
Spanish Room	623	71	31	0	Yes	Yes	Yes	Univent off-air flow obstructed by furniture, exhaust vent blocked by cart, door open
Cafeteria	950	71	31	~70	Yes	Yes	Yes	2 classrooms built within cafeteria-obstructing air flow, 3 univents-only 1 in cafeteria-straight line with exhaust vent, poor air circulation, spacial restrictions, univent off (motor in repair-work order)
Room 111	594	71	27	0	Yes	Yes	No	
Room 112	600	71	28	0	Yes	Yes	No	Univent off
Boy's Gym	759	70		~30	No	Yes	Yes	Exhaust weak, rooftop unit
Girl's Gym	739	67		26	No	Yes	Yes	

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Industrial Arts/Woodshop	544	66	28	1	Yes	Yes	Yes	Acrylic paint not sealed-evaporated/off-gassing-warning label, door open
Room 118	1011	68	32	23	Yes	Yes	Yes	Exhaust vent obstructed by table, door open
Room 117	752	69	29	15	Yes	Yes	No	Dehumidifier, 2 water-damaged CT
Room 119 (Art Room)	452	69	29	1	Yes	Yes	Yes	No air flow-no fan setting on thermostat, 10+ plants-standing water, temperature issues
Room 120 (Art Room)	694	70	30	25	Yes	Yes	Yes	Exhaust vent blocked, door open
Boy's Locker Room	592	69	29	0	No	Yes	Yes	Air handling unit off – reactivated by school maintenance
Health Ed Office	603	67	33	0	Yes	No	No	Cloth caulking, window-mounted air conditioner
Nurse's Office	796	68	33	3	No	No	No	2 water-damaged CT, 1 CT ajar, sink, hole, wall crack
Boy's Restroom 1st floor					Yes		Yes	Window open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

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	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 109A	975	70	34	5	Yes	Yes	Yes	Univent off, foam caulking, draft from around windows, wasp/fly bodies on windowsill, dry erase board, 2 computers
Girl's Restroom 1st floor					Yes		Yes	Window open, bamboo plant-water
Room 109	797	70	31	2	Yes	Yes	No	Window missing-sealed with plywood, bug bodies on windowsill, dry erase board, 4 water-damaged CT, door open
Room 107	665	70	30	9	Yes	Yes	Yes	Chalk dust, floor fan, 3 broken CT, pencil shavings, cleaning product
Room 105	667	69	30	13	Yes	Yes	Yes	Reported noise from univent-debris inside, 5 water-damaged CT, broken CT, door open, floor fan
Room 103	1007	70	29	0	Yes	Yes	Yes	Broken CT, dry erase board, door open
Room 101	836	69	31	4	Yes	Yes	Yes	Desk obstructing univent return, wastebasket obstructing exhaust vent, wall cracks, chalk dust, door open, accumulated items

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Modular Classroom 98	513	68	30	0	Yes	Yes	Yes	Double-paned thermal windows, 6 ceiling-mounted supply vents, door open, dry erase board, thermostat set to "on"
Modular Classroom 99	1221	70	35	22	Yes	Yes	Yes	Supply and exhaust off, thermostat set to "auto"
Room 108	1280	70	33	25	Yes	Yes	Yes	Dry erase board, sink, floor fan
Principal's Office	555	67	30	0	Yes	No	No	Personal heater
Guidance Office	770	67	35	1	No	No	No	Holes in CT, door open
Vice-Principal's Office	631	69	33	1	Yes	No	No	Window-mounted air conditioner, door open, water-damaged CT near pipe, 3 plants
Sick Area	734	69	34	0	No	No	No	
Psychology Office	595	72	31	0	Yes	No	No	Plant, CT ajar
Conference Room 2	970	71	33	1	No	No	No	CT ajar, broken CT, 2 doors-1 open

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Guidance	500	70	29	0	Yes	No	No	Window open, missing CT, window-mounted air conditioner-taped
Main Office	821	73	31	3	Yes	No	No	Photocopier, window-mounted air conditioner-taped, cloth caulking (drafts), dry erase board
Mrs. Wacks	792	73	29	1	Yes	No	No	3 plants, 3 water-damaged CT, exposed fiberglass
Teacher's Room	995	72	30	9	Yes	Yes	Yes	Window-mounted air conditioner-fan only function, missing CT, broken CT, bottled water obstructing exhaust vent
Teacher's Conference Room	675	71	30	0	No	No	No	2 computers, laminating machine, soda machine, 3 missing CT, door open
Copy Room	887	71	32	1	No	No	No	2 photocopiers, missing CTs, 2 CT with holes, door open
ESL Classroom	1089	71	31	2	No	Yes	No	Passive supply vent, former closet
Speech & Language	642	70	28	2	No	No	Yes	~12 broken CT, utility holes

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 8

Indoor Air Test Results – South Middle School, Braintree, MA – April 11, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Media Center Office	557	68	28	0	Yes	No	No	2 missing CT, door open, sink, books, accumulated items
Media Center	642	67	31	3	Yes	Yes	Yes	Univent blocked by carts, exhaust blocked by atlas stand, carpet, 6 water-damaged CT, 12 computers, debris in heater fins
Room 106	897	68	31	19	Yes	Yes	Yes	Floor fan, drafts around windows, 3 broken CT, chalk dust, door open
Room 104	751	68	31	16	Yes	Yes	Yes	Trash obstructing exhaust vent, floor fan, door open
Room 102	764	69	31	13	Yes	Yes	Yes	Trash obstructing exhaust vent, broken CT, plant, permanent markers, drafts around windows

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%